

**6th.**—Ovid, Iowa, windstorm. Conception, Mo., and Bismarck, N. Dak., thunderstorms.

**7th.**—Fairford, Ala., rainstorm. Chemung and Woodstock, Ill., stock killed by lightning. Sharon, Wis., and Lexington, Nebr., thunderstorms. In Furnas County, Nebr., man killed by lightning.

**8th.**—New York, N. Y., one person killed by lightning. Bethlehem, Pa., rainstorm. Philadelphia, Pa., and Baltimore, Md., thunderstorms. Akron, Ohio, windstorm. Garden Prairie and Marengo, Ill., thunderstorms. Sycamore, Ill., hailstorm. Newaygo, Mich., one person killed by lightning. Whitehall, Mich., 2 persons killed by lightning. Hanover, Mich., windstorm. Clinton, Mich., and Maryville, Mo., thunderstorms.

**9th.**—Bridgeton, N. J., York County, Pa., and Huntley, Ill., thunderstorms. Rochelle, Ill., one person killed by lightning. Saginaw, Mich., thunderstorm. Berrien Springs, Mich., windstorm. Columbus, Kans., a man and horse killed by lightning.

**10th.**—Leeds, Mass., windstorm. Winchendon, Mass., North Hammond and Buffalo, N. Y., thunderstorms. South Canisteo, N. Y. horse killed by lightning. Near Bayonne, N. J., thunderstorm. Nashville, Tenn., windstorm.

**12th.**—Memphis, Tenn., windstorm; one person killed. Charleston, Mo., windstorm; 2 persons killed.

**13th.**—Pierre, S. Dak., windstorm.

**14th.**—Westfield, Wis., windstorm.

**15th.**—Wahpeton, N. Dak., windstorm.

**16th.**—Columbia, S. C., and Marion, Kans., thunderstorms. Wamego, Kans., hailstorm.

**17th.**—Ashland, Va., thunderstorm.

**18th.**—Chester, N. J., thunderstorm. Madison, W. Va., thunderstorm.

**19th.**—Tampa, Fla., rainstorm.

**20th.**—Des Moines, Knoxville, Logan, and Osceola, Iowa, hailstorms. St. Joseph, Mo., windstorm. Olsburg and Glasco, Kans., thunderstorms. Beloit, Kans., hailstorm.

**21st.**—For description of tornadoes see report by Prof. Hazen.

**22d.**—Near Delphi, Ind., and near Van Wert, Ohio, windstorms. Richland Center, Wis., thunderstorm. New Hartford, Mo., stock killed by lightning. Bratton, Nebr., and Ellendale and Napoleon, N. Dak., windstorms.

**23d.**—Buffalo, N. Y., windstorm.

**25th.**—Malone, N. Y., hailstorm.

**26th.**—Everett, Mich., windstorm.

**27th.**—Delavan, Wis., thunderstorm.

#### THE VIOLENT LOCAL STORMS OF SEPTEMBER 21.

By Prof. H. A. HAZEN.

On this evening and night a very remarkable series of wind-rushes and tornadoes visited the northern part of Iowa, extreme southeast Minnesota, and west-central Wisconsin. It is very rare that destructive storms visit this region later than July; for example, the tornado at Grinnell, Iowa, occurred on June 17, 1882, and the one last year at Pomeroy was on July 6. On September 21, fortunately, no large town was struck, but the aggregate of deaths nearly equaled that at Pomeroy.

The conditions of the general storm, at 8 p. m., gave no inkling of the destruction so soon to be wrought. There were no maximum wind velocities reported from this region. The center of the general storm was very nearly over Sioux City, Iowa, at 8 p. m., and the next morning it was just east or southeast of Marquette, Mich.; its rate of motion was about 44 miles per hour, and its trajectory was about 100 miles to the northwest of the principal violent storms in Iowa. The maximum temperature on this day, at Sioux City, was 80°, and at La Crosse, 76°, which was not at all

abnormal. On the day previous there had been thunderstorms and hail at several points in Iowa and Missouri. These showed an electric disturbance in this region, but of no marked severity.

On the 21st the first signs of violence were noted at Le Mars and Seney, in Plymouth Co., Iowa, at about 7 p. m. A little later Lincoln and Riverton townships, in Clay Co., were visited. A great many towns were struck in a line from this point to the northeast point of Iowa and the southeast corner of Minnesota. There seemed to be two lines of destruction, as follows:

Track I, Ruthven, 7.30; Emmetsburg, 7.30; Cylinder, 8; Whittemore and Algona, 8.15; Wesley, 8.30; Britt, 8.30; Ellington and Hayfield, 9; Concord and Mason City, 9.20; Osage, 10; New Haven, 10.20; Lowther, Elms, Cresco, and Burroak, 11—all in Iowa. This was the best traced line and seemed to show a velocity of 43 miles per hour. It will be noted that this coincides almost exactly with the velocity of the general storm.

Track II passed through the following points: Fenton, 8.30; Burt, 8.00; Forest City, 9.30; Fertile, 9.30; St. Ansgar, 10—all in Iowa. Le Roy, 10; Spring Valley, 10.10; Chatfield, and Laird, 10.30; Eyota, 10.30; Homer, 11—all in Minnesota; Marshland, Wis. This storm turned in its course at Fertile, and moved in an east-northeast direction, at first turning northeast between Le Roy and Spring Valley.

Track III was nearly parallel to II, and struck York and Greenleaf, the later town at 11 p. m.

Track IV passed through Waseca, Otisco, Dodge Center, and Beaver, 9.30 p. m.—all in Minnesota.

There were also destructive storms at Richland Center at 11.30, and Marshall between midnight and 1 a. m., of the 22d.

The characteristics of these storms were the same as have been noted repeatedly before. The earlier tracks lay more to the north and northwest, and as the night wore on the later ones lay further east. The general direction of all the paths was toward the east, or a little north of east.

Fifty-three lives were lost in Iowa and 5 in Minnesota. The earlier reports were very much exaggerated, thus, 50 killed in Winnebago County, 100 in Iowa, etc. The above estimate of 53 is a careful one, and is probably true within 3 or 4.

Losses to buildings were approximately as follows: In Iowa, Cerro Gordo County, \$3,000; Hancock County, \$40,000; Kosuth County, \$30,000 to \$50,000; Emmetsburg, \$7,000 to \$9,000; Fertile, \$1,000; New Haven, \$2,700; Osage, \$9,000; Ruthven, \$1,100; St. Ansgar, \$15,000; Thompson, \$3,500. In Minnesota: Eyota, \$2,000; Greenleaf, \$1,000; Homer, \$2,000; Hutton, \$700; Laird, \$2,000 to \$4,000; Le Roy, \$120,000; Spring Valley, \$59,875. Richland Center, Wis., \$4,000. This makes the total estimated and reported loss as \$312,000; the whole loss was probably less than \$350,000.

Rather full descriptions of these violent storms have been received from 27 stations. Sixteen towns report a funnel cloud, in one place 3 were seen. Twenty-six report lightning in this storm; 16 of them describe it as violent, vivid, sharp, incessant, etc.; 12 report a whirl, 8 counter-clockwise, 2 clockwise.

Sixteen reports mention the distribution of debris, and all describe this as carried with the storm or turned inward toward the track. Three indicate that on the north side objects were carried to northeast and west. One states that the first fall of trees on north side was toward the west and then others were piled on top toward the east. Eight report a glow, or white appearance in cloud; one observer says it looked like a cone of steam; another likens it to a "pillar of fire;" two report that it was very black. Eight state that there were two clouds that came together to the west of the town.

In one place 35 persons were injured, and all these stated

that it seemed as though thousands of needles were pricking them as the storm passed. It should be noted that as these storms occurred after dark, there was a very favorable oppor-

tunity for observing lightning, but not for noting other phenomena of these violent storms. Several spoke of observing the funnel cloud by the light of the vivid flashes of lightning.

### INLAND NAVIGATION.

#### STAGE OF WATER IN RIVERS.

The following table shows the danger point and the highest and lowest stages for the month of September, 1894:

*Heights of rivers above low-water mark, September, 1894.*

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Height.	Date.	Height.	Date.	
<i>Red River.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>
Shreveport, La. ....	29.2	— 2.5	1, 29	— 3.7	10	1.2
<i>Arkansas River.</i>						
Fort Smith, Ark. ....	22.0	11.3	16	0.7	1	10.6
Little Rock, Ark. ....	23.0	9.8	18	2.9	3, 4	6.9
<i>Missouri River.</i>						
Bismarck, N. Dak. ....	75.0	.....	.....	.....	.....	.....
Pierre, S. Dak. ....	13.0	2.2	1	1.8	21, 22	0.4
Sioux City, Iowa ....	18.7	7.7	1	6.1	28, 29	1.6
Omaha, Nebr. ....	18.0	8.2	1	6.6	30	1.6
Kansas City, Mo. ....	21.0	9.7	3	6.7	29, 30	3.0
<i>Mississippi River.</i>						
St. Paul, Minn. ....	14.0	1.9	16-18	1.4	2	0.5
La Crosse, Wis. ....	10.0	1.3	23-27	0.9	5, 6, 14-19	0.4
Dubuque, Iowa ....	16.0	.....	.....	.....	.....	.....
Davenport, Iowa ....	15.0	1.6	11, 12	0.1	1-7	0.5
Keokuk, Iowa ....	14.0	1.9	24	— 0.7	1-3	2.6
Hannibal, Mo. ....	17.0	2.6	25	— 0.2	1-3	2.8
St. Louis, Mo. ....	30.0	6.1	18	3.4	3, 4	2.7
Cairo, Ill. ....	40.0	6.4	21	5.1	5	1.3
Memphis, Tenn. ....	33.0	1.9	1	1.0	8, 9	0.9
Vicksburg, Miss. ....	41.0	2.2	28, 29	— 0.2	14	2.4
New Orleans, La. ....	13.0	4.2	20, 21	3.0	1, 2	1.2
<i>Ohio River.</i>						
Parkersburg, W. Va. ....	38.0	12.4	23	0.3	10, 11	12.1
Cincinnati, Ohio ....	45.0	13.0	27	3.1	14, 15	9.9
Louisville, Ky. ....	24.0	0.7	29	2.6	18-20	4.1

#### Heights of rivers—Continued.

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Height.	Date.	Height.	Date.	
<i>Cumberland River.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>
Nashville, Tenn. ....	40.0	1.7	18, 20	0.4	28-30	1.3
<i>Tennessee River.</i>						
Chattanooga, Tenn. ....	33.0	4.0	1	0.8	30	3.2
Knoxville, Tenn. ....	29.0	.....	.....	.....	.....	.....
<i>Monongahela River.</i>						
Pittsburg, Pa. ....	22.0	10.6	21	2.0	28	8.6
<i>Savannah River.</i>						
Augusta, Ga. ....	32.6	13.7	19	5.0	13	8.7
<i>Willamette River.</i>						
Portland, Oregon ....	15.0	6.3	2	2.2	24	4.1
<i>Susquehanna River.</i>						
Harrisburg, Pa. ....	17.0	.....	.....	.....	.....	.....
<i>Alabama River.</i>						
Montgomery, Ala. ....	48.0	4.7	22	0.0	7	4.7
<i>James River.</i>						
Lynchburg, Va. ....	18.0	1.5	1, 30	— 0.2	13-18	1.7
<i>Sacramento River.</i>						
Red Bluff, Cal. ....	22.0	1.2	30	0.6	23-25	0.6
Sacramento, Cal. ....	25.0	8.2	1, 2	7.5	13-30	0.7
<i>Des Moines River.</i>						
Des Moines, Iowa ....	19.0	4.0	9	2.8	10, 11, 14-19, 26-28.	1.2

\* Record for 22 days.

The above table shows that no floods occurred during the month in the rivers therein tabulated. In most cases the rivers were unusually low.

### ATMOSPHERIC ELECTRICITY.

#### GENERAL STATISTICS.

The table showing in detail for September, 1894, the statistics relative to auroras and thunderstorms is placed among the meteorological tables as No. XI, instead of being given in the text as heretofore. It shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month. It is not certain that all the meteorological stations are equally faithful in reporting thunderstorms and auroras, and it is therefore necessary for the student to guard against the assumption that the frequency of these phenomena varies with the number of the reports. Even if the number of reports be divided by the number of stations in each State, the percentages of frequency thus obtained are liable to a similar uncertainty, and therefore for the present such percentages are omitted.

In comparing the relative frequency of thunderstorms or auroras in different portions of the globe and at different seasons of the year it is customary, and, in fact, imperative, to ignore the number of stations and the number of reports as such and to consider only the number of days on which the phenomena occur. In such studies, therefore, the number of stations is of importance principally as an indication of the probability that all of the thunderstorms and auroras have been recorded. Even from this point of view, however, it is necessary to know not merely the number of stations, but their geographical distribution within each State as an assurance against overlooking any very local phenomena that might have occurred only in the regions where no observer was at hand. Owing to the want of space in Table XI,

the publication of the necessary data here referred to will be delayed until the annual summary.

#### THUNDERSTORMS.

A mention of the more severe thunderstorms reported during the month is given under "Local storms." The dates on which reports of thunderstorms were most numerous were: 8th, 181; 10th, 171; 5th, 138; 9th, 134; 14th, 121; 7th, 106.

The States where thunderstorm reports were most numerous were: Missouri, Pennsylvania, Ohio, Iowa, Kansas, Florida, and Illinois.

The States where the dates of thunderstorms were most frequent were: Florida, where they were recorded on 23 days; Missouri, on 22 days; Kansas and Michigan, on 20 days.

#### DAMAGE BY LIGHTNING.

The following statistics of the damage done by lightning in September, so far as reported by the observers of this Bureau, are furnished by Mr. Alexander McAdie:

During September, 1894, 29 persons were killed and 14 severely injured; 56 barns were struck, with a loss of not less than \$141,350; 42 dwelling houses were struck and a number of churches, several schoolhouses, 1 armory, and 1 railroad depot.

#### AURORAS.

The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four days preceding and following the date of full moon, viz, from the 10th to the 18th, inclusive. On the remaining twenty-one days of the month 243 reports were received, or an average of 12 per day. The dates on which the reported number especially exceeded this average were the 27th, 73;